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FINAL ENVIRONMENTAL ASSESSMENT

BROWNS FERRY NUCLEAR PLANT UNITS 2 AND 3 EXTENDED POWER UPRATE PROJECT

Limestone County, Alabama

TENNESSEE VALLEY AUTHORITY

AUGUST 2003

Final Environmental Assessment **August 2003**

Proposed project: Browns Ferry Nuclear Plant Units 2 and 3 Extended Power Uprate Project
Limestone County, Alabama

Lead agency: Tennessee Valley Authority

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Abstract: The Tennessee Valley Authority (TVA) proposes to increase the reactor thermal power for Browns Ferry Nuclear Plant (BFN) Units 2 and 3 such that the reactors can be operated at 120 percent of their original licensed thermal power (OLTP) of 3,293 megawatts thermal. This proposal was previously evaluated in the TVA March 2001 *Browns Ferry Nuclear Plant Extended Power Uprate for Units 2 and 3 Final Environmental Assessment*. This previous EA included commitments to mitigate potential thermal impacts to surface waters by use of existing cooling towers and addition of a new cooling tower. TVA elected to review the proposed project again because newly available technical and economic analyses indicated that a different approach to mitigating potential thermal impacts has become more appropriate. Operating BFN Units 2 and 3 at 120 percent of OLTP would have less impact than operating Units 1 through 3 at 100 percent of OLTP. The principal environmental impact would be slightly increased thermal loading to the waters of Wheeler Reservoir above current operations of Units 2 and 3 at 105 percent of OLTP, but still less than presently permitted levels. This impact would be mitigated by using existing cooling towers and derating BFN as necessary to maintain compliance with the existing National Pollutant Discharge Elimination System permit.

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CHAPTER 1

1. PURPOSE OF AND NEED FOR ACTION

1.1. The Proposed Decision

The Tennessee Valley Authority (TVA) proposes to increase the reactor thermal power for Browns Ferry Nuclear Plant (BFN) Units 2 and 3 such that the reactors can be operated at 120 percent of their original licensed thermal power (OLTP) of 3,293 megawatts thermal (MWt). This proposal was previously evaluated in the TVA March 2001 *Browns Ferry Nuclear Plant Extended Power Uprate for Units 2 and 3 Final Environmental Assessment* (EA) (TVA, 2001). Since newly available technical and economic analyses indicate that a different approach to mitigating potential thermal impacts has become more appropriate, TVA has elected to review anew the environmental impacts potentially resulting from this proposal.

1.2. Need for TVA Action

With the aid of stakeholders in the Tennessee Valley, in 1995 TVA completed *Energy Vision 2020 - Integrated Resource Plan/Programmatic Environmental Impact Statement*. *Energy Vision 2020* projected demands for electricity in the TVA power service area through the year 2020 and evaluated and recommended ways of meeting the projected increases. Over the past several years, strong economic growth in the TVA service area with the corresponding increase in energy need has increased the demand for electricity.

Based on peaking and baseload demands recorded in recent years, the medium load capacities targeted in *Energy Vision 2020* may actually be too conservative. Actual peak demands increased by over 4,600 megawatts (MW) from the winter of 1995 (24,723 MW) to the summer of 2000 (29,344 MW): an average annual increase of about 920 MW (over 3 percent per year). Peaking demands during the summer of 2000 exceeded by 2,000 MW the medium load forecast contained in *Energy Vision 2020*. TVA met a new all-time peak load of 29,866 MW in January 2003. Continued demand increases of this magnitude could, in a few years, exceed TVA’s generation capacity and negatively affect TVA’s ability to serve its customers. The addition of approximately 250 megawatts-electric (MWe) of capacity at the currently operating BFN units provides a cost-effective means to meet the projected increased need for additional generating capacity by effectively utilizing an existing asset without a significant environmental impact.

1.3. Background

The increases in reactor thermal power in the range proposed by TVA for Units 2 and 3 at BFN are termed by the Nuclear Regulatory Commission (NRC) as “extended power uprates” or EPUs. These power uprates are typically defined by NRC as uprates greater than 7 percent and up to 20 percent of OLTP. Such uprates generally require modifications to balance-of-plant equipment, such as high-pressure turbine condensate pumps and motors and main generators. As of July 23, 2003, the official Web site of the NRC (NRC, 2003) indicated that, excluding those plants with provisional operating licenses, EPUs for 11 nuclear units had been approved by NRC, and an additional 15 license amendment applications for such uprates are expected between 2003 and 2008.

In 1998, BFN completed an Integrated Plant Improvement Project for Browns Ferry Units 2 and 3, which, among other improvements, resulted in a 5 percent uprate of the OLTP for both units (3,293 to 3,458 MWt). Uprates of this nature are termed “stretch” uprates by NRC (NRC, 2003). The impacts of this action were evaluated in an EA dated August 1997. NRC issued the EA and Finding of No Significant Impact (FONSI) related to the October 1, 1997, application for a 5 percent power uprate on August 26, 1998. A license amendment to the Browns Ferry operating license was approved by NRC for the 5 percent uprate on September 8, 1998. The NRC recently approved a Licensing Topical Report, "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate," NEDC 32424P-A, February 1999, and "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate," NEDC 32523P-A, February 2000, which establishes the generic methodology to uprate the power output of boiling water reactors such as the BFN units up to 120 percent of the OLTP. For the currently proposed project, TVA would obtain a license amendment from the NRC to allow Units 2 and 3 to operate up to 120 percent of the OLTP. The impacts of (1) the license renewal for Units 2 and 3 for an additional 20 years of operations beyond their current operating licenses, (2) the possible restart, license extension, and uprate of BFN Unit 1, and (3) construction of an independent spent fuel storage facility were assessed in a TVA, 2002, Supplemental Environmental Impact Statement (SEIS). The proposed project to uprate Units 2 and 3 would be feasible, independent of any decisions TVA has made regarding the license extension of Units 1, 2, and 3 and the possible restart of Unit 1.

This EA was prepared in accordance with the National Environmental Policy Act (NEPA) and TVA’s implementing procedures. It addresses specific issues and potential environmental impacts associated with the proposed action.

1.4. Other Pertinent Environmental Reviews or Documentation

The Final SEIS for Operating License Renewal of the Browns Ferry Nuclear Plant in Athens, Alabama (TVA, 2002) included an evaluation of the potential environmental impacts of two action alternatives, Alternative 1, operating BFN Units 2 and 3 at 120 percent of OLTP for an additional 20 years beyond current operating licenses, and Alternative 2, refurbishment and restart of BFN Unit 1 with relicensing of all three units. Both Action Alternatives initially contemplated the installation of new cooling towers to mitigate the increased thermal loading to Wheeler Reservoir. Computer modeling analyses for Alternative 1 included an assumption of the installation of a new 16-cell mechanical draft cooling tower, use of existing cooling towers, and derating as necessary to mitigate the thermal impacts. Alternative 2, refurbishment and restart of BFN Unit 1 with relicensing of all three units, was adopted by the TVA Board as reflected in the record of decision (ROD) issued in May 2002. For the restart of Unit 1, the mitigation strategy for increased thermal loads to surface waters included use of existing cooling towers, construction of a new 20-cell cooling tower, and derating as necessary.

The *Browns Ferry Nuclear Plant Extended Power Uprate for Units 2 and 3 EA* (TVA, 2001), which was completed in March 2001, described the potential environmental effects of increasing power thermal output from BFN Units 2 and 3 from 105 percent to 120 percent of OLTP. A FONSI was issued for the proposed project contingent upon certain mitigation measures for rendering increased thermal loads to surface waters insignificant. Thermal impact mitigation measures included construction of a new 16-cell cooling tower and the use of existing cooling towers. After the March 2001 FONSI was issued, additional technical analyses completed late in 2001 predicted that without the new cooling tower, which was specified as a mitigation measure, the plant would only need to derate for 183 hours in a 10-year period. Subsequent model refinements using 16 years of data predicted that operation of BFN Units 2 and 3 at 120 percent of OLTP without the proposed new cooling tower would only require 128 hours of derating in the 16-year period. Further, economic analysis indicated that due to transmission system improvements, the cost of replacement power for that number of hours (i.e., 128 hours) over a 16-year period would not be enough to justify construction of a new cooling tower as a part of the EPU project for Units 2 and 3. This change in project economics, the need to add sections addressing socioeconomics and environmental justice concerns, and ADEM's recent determination that the designated water quality uses for Wheeler Reservoir with respect to temperature are not impaired (ADEM, 2002), prompted TVA to review anew the impacts of the EPU project for BFN Units 2 and 3.

These and other related environmental reviews are shown in Table 1-1.

1.5. The Scoping Process

In preparing this EA, TVA assembled a core team from the following entities within TVA: Browns Ferry Nuclear Plant, Nuclear Licensing, River Operations, Communications, Resource Stewardship, Office of the General Counsel, Environmental Policy and Planning, and NEPA Administration. The core team met on March 25, 2003, to discuss the proposed extended power uprate for BFN Units 2 and 3 and the adequacy of the previous EA that had been completed in March 2001 (TVA, 2001). Because new data affecting the economics of the project had become available and because additional water quality data had been accumulated since the previous EA, the core team decided to proceed with additional environmental review. An interdisciplinary team (IDT) for conducting the review was selected. The IDT met on April 30, 2003. From discussions among the core team and the IDT, the following issues were identified: spent fuel storage, generation of solid and hazardous wastes, radiological health, surface water quality, aquatic ecology, threatened or endangered species, and socioeconomic/environmental justice. Potential effects to these areas have been evaluated in this EA. Resources and issues for which there was no potential or only a *de minimis* potential for effects include groundwater, floodplains, wetlands, historic properties/cultural heritage, visual and recreational resources, transportation, terrestrial ecology, noise, and land use.

1.6. Necessary Federal Permits or Licenses

In order for TVA to implement the proposed action, the NRC would have to issue an amendment to the operating licenses for BFN Units 2 and 3.

Table 1-1. Environmental Reviews Related to Supplemental EA for BFN Units 2 and 3 Extended Power Uprate

Type of Review	Title	Result/Date	Summary/Relevance for this Review
SEIS	Final Supplemental Environmental Impact Statement (SEIS) for Operating License Renewal of the Browns Ferry Nuclear Plant in Athens, Alabama	Record of Decision (ROD) issued 5/16/2002	Decision was to seek extension of NRC licenses for BFN Units 1 through 3 at 120 percent of OLTP for an additional 20 years beyond original 40-year operating license terms. Mitigation measures for increased thermal loads to surface waters included use of existing cooling towers, construction of a new cooling tower, and derating the plant as necessary.
EA	Browns Ferry Nuclear Plant Extended Power Uprate for Units 2 and 3 EA	FONSI issued 3/15/2001	Action was to propose a project to request an increase in the output of BFN Units 2 and 3 from 105 percent of OLTP to 120 percent. Since the proposed mitigation has changed, and additional data and analyses have become available, TVA has elected to review anew the environmental impacts potentially resulting from the proposal.
EA	Browns Ferry Nuclear Plant Units 2 and 3 Power Uprate Project EA	FONSI issued 8/28/1997	Action was to request license amendment from NRC to uprate BFN Units 2 and 3 to 105 percent of OLTP.
EIS	Energy Vision 2020 – Integrated Resource Plan/Programmatic Environmental Impact Statement (EIS)	ROD issued 2/22/1996	Documents TVA’s long-term strategies for meeting demands for electric power.
EIS	Browns Ferry Nuclear Plant, Units 1, 2, and 3 Final EIS	Atomic Energy Commission accepted as adequate to support licensing on 8/28/1972	This document evaluated potential environmental impacts for originally proposed 40-year life of BFN.

CHAPTER 2

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

The proposed action involves construction activities as well as changes to current operations. Physical construction activities would be a minor, temporary addition to an existing industrial facility having a substantial property buffer. Minor, temporary construction impacts could occur. Potential for environmental effects would primarily be related to operational aspects.

2.1. Alternatives

The alternatives being considered are to extend the power uprate to BFN Units 2 and 3 to 120 percent of original licensed thermal power (OLTP) and the No Action Alternative.

2.1.1. Alternative A – The No Action Alternative

Under the No Action Alternative, the BFN Units 2 and 3 would continue to operate at the currently licensed power levels (3,458 MWt).

2.1.2. Alternative B – Uprate Units 2 and 3 at Browns Ferry Nuclear Plant to 120 percent Original Licensed Thermal Power

The proposed action is to seek a license amendment from NRC to operate BFN Units 2 and 3 at up to 120 percent of the OLTP (3,293 to 3,952 MWt), resulting in approximately 250 MWe of additional electrical output from BFN.

A new operating philosophy would be established whereby reactor power would be adjusted as seasonal changes in river temperature affect the overall efficiency of the turbine to maintain generator output at a constant level (approximately 1,280 MWe) throughout the year. This new operating approach means that, at times during the year, reactor steam and feedwater flow could approach levels of 120-122 percent of the original operating basis.

To accommodate the increased reactor steam and feedwater flow and to accommodate the increased heat rejected, the following modifications to plant equipment are expected to be necessary. The exact nature of these modifications can be determined only after engineering evaluations are completed.

1. Modifications to the high-pressure turbine steam path
2. Modifications to the reactor feed pump turbines
3. Installation of higher horsepower condensate pump motors
4. Modifications to the condensate demineralizer system
5. Installation of new heater drain valves
6. Possible installation of some miscellaneous safety system setpoint changes

All changes are within the existing structures and buildings housing the major unit components. The project would make use of existing parking lots, road access, laydown areas, offices, workshops, warehouses, and restrooms already located in previously disturbed surface areas at BFN. No changes to transmission lines or the switchyard would be required.

All deliveries of materials would be by truck to support the work identified above. It is anticipated that about 25 (no more than 30) deliveries of material would occur over a one-year period (two to two and one-half per month on average). Equipment would be unloaded in existing receiving areas with unloading equipment already on site and temporarily stored in existing laydown areas. Existing land uses would not be altered.

As many as 1,000 additional workers would be on site during the 35-day period required for the modifications. It is anticipated that mobilization would occur about two weeks prior to this period, and the number of workers would peak at as many as 1,000 about three weeks into the outage, then tail off during the final ten days of the outage.

2.2. Comparison of Alternatives

If extended power uprate is implemented for BFN Units 2 and 3, an additional electric generating capacity of approximately 250 MWe would be added to the TVA system. If the extended power uprate is not implemented, the small increases in environmental impacts resulting from the proposed EPU would not occur. However, the additional approximate 250 MWe of generating capacity would need to be acquired from an alternative energy source. Other alternatives include demand-side management and conservation, new generating plants, repowering of existing coal-fired plants, and power purchases from other utilities. For a capacity need of approximately 250 MWe under the No Action Alternative, TVA would most likely purchase the power from existing gas-fired generators and in the long term as the need for capacity grew, consider additional TVA gas-fired capacity. With the possible exception of demand-side management and conservation, the environmental impacts of uprating BFN are substantially less than those of other power supply alternatives involving fossil fuels or purchases from other utilities that also generate with fossil fuels. Although speculative, these alternative energy sources could result in impacts to air quality (i.e., emission of sulfur dioxide, nitrogen oxides, carbon dioxide, or other atmospheric pollutants), water quality, land use (for siting of new plants), and generation of additional solid and hazardous wastes.

As compared to the No Action Alternative, minor impacts would occur with implementation of the proposed action. Some of the plant modifications required to implement the EPU may result in the generation of small amounts of hazardous and solid wastes. BFN currently has in place the necessary procedures and contracts for proper disposal of both types of waste. The capacity of the BFN landfill and the local landfills is adequate to accommodate the additional solid waste.

The increased thermal power proposed for this project would result in an increase of approximately 2.3 degrees Fahrenheit (ºF) in the temperature of the circulating water leaving the main condenser from that currently experienced. This increase in discharge temperature would result in increased cooling tower usage during summer periods to maintain compliance with the discharge limitations. No changes are expected to be required to the plant intake system or intake flow rates because of this project. The amount of water withdrawn from the river remains within levels evaluated during the original Environmental Impact Statement (EIS) impact analysis for three-unit operation at BFN; therefore, neither Alternative A nor B would impact impingement/entrainment levels at BFN. As compared to current operations, potential radiological effects to the public resulting from plant radioactive effluents from operation of BFN under extended power uprate would not significantly change the maximum projected annual dose or cumulative dose over time. Radiological doses for extended uprate conditions would be well below the regulatory limits and would have no effect on human health. Impacts to aquatic communities by operation at either current or uprated power levels would be minimal and insignificant. No effects to threatened or endangered species would occur.

While this increase in capacity would result in minor increases in the thermal load to the Tennessee River resulting from operation of BFN, these increases are small, and could be accommodated without changes to existing permit limitations. An amendment to the operating license for BFN Units 2 and 3 from the NRC would be required.

Prior to the restart of Unit 1, the impacts for operating Units 2 and 3 at 120 percent of OLTP remain within the bounds of the original environmental impacts identified for three-unit operation at BFN. After the restart of Unit 1, the cumulative impacts of operating all three units at 120 percent of OLTP have been described in detail in the Browns Ferry Relicensing SEIS (TVA, 2002) and found to be insignificant with the commitments therein.

2.3. The Preferred Alternative

TVA's preferred alternative is Alternative B, i.e., to increase the reactor thermal power for BFN Units 2 and 3 such that the reactors can be operated at 120 percent of their OLTP of 3,293 MW. The preferred means of maintaining BFN compliance with the existing National Pollutant Discharge Elimination System (NPDES) water discharge permit and mitigating potentially increased thermal loads to Wheeler Reservoir is to use the existing cooling towers in conjunction with derating BFN Units 2 and 3.

CHAPTER 3

3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1. Site Description

BFN is located on an 840-acre tract on the north shore of Wheeler Reservoir at Tennessee River Mile (TRM) 294 in Limestone County, Alabama. The site is approximately ten miles northwest of Decatur, Alabama and ten miles southwest of Athens, Alabama. The plant has three licensed reactors, two of which are currently in operation (Units 2 and 3). Unit 1 is currently in nonoperational status.

Wheeler Reservoir was created in 1936 and has an area of 67,070 acres and a volume of 1,050,000 acre-feet at the normal summer pool elevation of 556 feet (mean sea level). Most of Wheeler Reservoir is classified by the Alabama Department of Environmental Management (ADEM) for use as public water supply, swimming and other whole-body water-contact sports, and fish and wildlife. However, the area of the reservoir immediately upstream and downstream of BFN is not classified for public water supply. Water quality is generally good and is suitable for the designated uses. The section of Wheeler Reservoir from the Elk River to Wheeler Dam was on the 2000 Alabama 303(d) list as partially supporting its designated uses due to pH and temperature/thermal modifications caused by industrial sources and flow regulation and modification. However, in 2002, ADEM determined that the mean temperatures in the photic zone (top four meters in the water column) are statistically similar to values measured at other locations along the Tennessee River and that designated uses of Wheeler Reservoir are not impaired due to pH and temperature (ADEM, 2002).

Water temperature patterns in Wheeler Reservoir are constantly changing in response to varying meteorological and flow conditions. Natural water temperatures in the reservoir vary from around 35 degrees Fahrenheit (ºF) in January to around 90ºF in July. Temperature patterns upstream of BFN are fully mixed during the fall, winter, and spring, with weak thermal stratification from June through September.

There are eight potable water intakes on Wheeler Reservoir withdrawing a total of approximately 124 million gallons per day (mgd) for municipal and industrial use. Wastewater discharges include 11 municipal plants discharging approximately 30 mgd. Eighteen industrial plants discharge approximately 2,513 mgd. The largest discharge by far is cooling water from BFN. Consumptive and off-stream water uses do not conflict significantly due to the large volume of reservoir water available, the river flow rate that has 24-hour average minimum flows ranging from 5,000 cubic feet per second (cfs) to 10,000 cfs, and the return of most of the water withdrawn.

3.2. Impacts Evaluated

The scoping process identified the following issues with potential for substantive environmental effects: spent fuel storage, generation of solid and hazardous wastes, radiological health, surface water resources, aquatic ecology, threatened or endangered species, and socioeconomic/environmental justice.

The proposed action would not substantively increase the probability or consequences of accidents, no changes are being made in the types of effluents that may be released off site, and there is no significant increase in occupational or public radiation exposure. Therefore, there are no significant radiological environmental impacts associated with the proposed action.

With regard to potential nonradiological impacts, the proposed action does not have a potential to affect any historic sites, cause land use changes, or create significant effects from the additional noise or fugitive dust generated during construction activities on this industrial site.

3.2.1. Spent Fuel Storage

Although the proposed EPU would increase the average batch size of fuel assemblies needed for a refueling from the current 288 to approximately 332 with the uprate, the required BFN schedule for spent fuel storage expansion (i.e., dry storage) would not be affected. The impact of EPU on spent fuel storage is that the number of dry storage casks required would increase by approximately 7 percent with EPU implementation. Implementation of the Dry Cask Storage Project was reviewed as part of the TVA SEIS for relicensing of the three units and restart of Unit 1 at BFN (TVA, 2002). The additional spent fuel generated as a result of EPU would not have a significant impact, since this additional spent fuel would be accommodated in the dry cask facility pending the shipment of the waste to United States Department of Energy's geological repository.

3.2.2. Hazardous Waste

BFN is currently classified as a large quantity generator of hazardous waste. Some of the plant modifications required to implement the EPU may result in the generation of small amounts of hazardous waste that must be properly handled and disposed. Neither the types nor amounts of waste generated are expected to be different from those routinely handled at BFN. No new waste streams are anticipated due to the uprate activities. Typical hazardous waste types produced as a result of these activities include spent solvents used in cleaning and degreasing activities and paint-related wastes from coating activities. The volumes of waste produced are expected to be within the ranges experienced in previous years, and would not impact site hazardous waste reduction goals. Hazardous wastes generated at BFN are managed through the TVA Hazardous Waste Storage Facility (HWSF) in Muscle Shoals, Alabama. The HWSF maintains contracts with a variety of companies who provide disposal services for TVA generated waste materials.

3.2.3. Solid Waste

BFN currently has a permitted construction/demolition landfill that can accommodate some of the waste material and contracts with local haulers to dispose of most solid waste in permitted municipal landfills. As with the hazardous waste described above, some of the modifications would result in the generation of solid wastes that require disposal. Based on plant experience with previous similar modifications and construction activities, the types of wastes produced are not out of the ordinary for activities of this type. Typical solid wastes include scrap lumber and packing materials and miscellaneous construction-related debris. Neither the capacity of the BFN landfill nor the local landfills would be impacted by the volume of waste produced as a result of this project.

3.2.4. Low-Level Radioactive Waste

Operation of BFN Units 2 and 3 at the proposed uprated power levels would result in generation of 15-20 percent more radioactive resin as a result of the increased condensate demineralizer flow. The existing radioactive waste treatment and temporary storage systems at BFN are capable of accommodating this increased waste generation without modification. The small amount of dry active waste that would be generated because of modification activities within the plant would remain within the range of waste volumes currently generated and would not impact waste generation goals.

3.2.5. Radiological Impacts - Normal Operation

To assess the impact of increased gaseous and liquid effluent releases, the maximum projected dose to the public because of the effluent releases resulting from operation at uprated conditions was compared to the current dose and to the NRC and United States Environmental Protection Agency (EPA) limitations (Table 3-1).

Table 3-1. Maximum Dose Due to Radioactive Effluent Releases - Browns Ferry Nuclear Plant

TYPE	NRC LIMIT	EPA LIMIT	1994-1996 CURRENT AVERAGE DOSE	PROJECTED AVERAGE DOSE	PERCENT OF NRC LIMIT CURRENT/ PROJECTED	PERCENT OF EPA LIMIT CURRENT/ PROJECTED
LIQUID EFFLUENTS (millirem/year)						
Total Body	3	25	0.054	0.065	1.8/2.2	0.2/0.3
Any Organ	10	25	0.078	0.094	0.8/0.94	0.3/0.4
GASEOUS EFFLUENTS (millirem/year)						
Noble Gas (Gamma)	10	25	0.00098	0.0012	0.009/0.012	0.004/0.005
Noble Gas (Beta)	20	25	0.0014	0.0017	0.007/0.009	0.006/0.007
Any Organ	15	25	0.035	0.042	0.23/0.28	0.14/0.17

These data indicate that under normal operating conditions, operation of BFN at EPU conditions would not significantly change the maximum projected annual dose or cumulative dose over time to the public resulting from plant radioactive effluents. It is also important to note that the data for the liquid effluents from Table 3-1 do not take into account operation of the on-site recycling process.

The quantity of the isotope nitrogen-16 (N-16) in the reactor water and turbine building would be expected to increase linearly with the EPU. Any discernible increase in radiation due to increased N-16 would be measured on the site environmental thermoluminescent dosimeter (TLD) stations. Past history from these TLD stations has not shown any measurable N-16 radiation at off-site locations. Therefore, it is unlikely that the increase in N-16 source term due to EPU would result in any measurable dose to the public.

3.2.6. Occupational Radiation Dose

Occupational radiation dose would be expected to increase linearly with the EPU. Administrative and radiological controls constraining individual radiation dose below 10 Code of Federal Regulation (CFR) 20 radiation dose limits are a programmatic requirement. The facility average annual occupational radiation dose during the ten-year period 1991 through 2000 is 0.198 rem. A linear extrapolation forecasts an annual average occupational dose less than 0.24 rem; approximately 5 percent of the 10CFR20 adult whole body occupational radiation dose limit. These data do not take into account ALARA program initiatives and administrative dose level controls.

3.2.7. Radiological Impacts - Accident Related

The radiological consequences resulting from the postulated events (loss of coolant accident, main steam line break accident, fuel-handling accident, and the control rod drop accident) have been evaluated using NRC accepted methods. The results indicate existing regulatory requirements would continue to be met.

3.2.8. Surface Water Resources/Thermal Effects

3.2.8.1. Existing Operations and Potential Impacts

Under normal operation, BFN uses a once-through circulating water system to dissipate heat from the main turbine condensers. Water is withdrawn from the Tennessee River by the plant intake system and is discharged back to the river through submerged diffusers located on the river bottom and oriented perpendicular to the river flow. The diffusers are designed to enhance mixing of the heated effluent and the ambient water by discharging the effluent through 2-inch diameter ports (7,800 per unit, 23,400 total) located on the downstream-facing portion of the diffuser pipe and angled to force the heated effluent up into the water column.

In addition to the once-through system, BFN currently has five mechanical draft cooling towers that can be operated to assist in heat dissipation (helper mode) primarily during summer hot-weather periods. BFN has an NPDES permit (Number AL0022080) issued by the state of Alabama that contains specific requirements applicable to the nonradiological effluents released from BFN. Browns Ferry’s current thermal limitations are a maximum 1-hour average of 93°F, and a maximum 24-hour average of 90°F, with a maximum temperature rise of 10°F over ambient conditions. All limitations are applied at the end of a 2,400-foot mixing zone downstream of the diffusers.

The increased thermal power proposed for this project would result in an increase of approximately 2.3°F in the temperature of the circulating water leaving the main condenser. This increase in discharge temperature would result in increased cooling tower usage during summer periods to maintain compliance with the discharge limitations.

Effluent discharges from other plant systems such as yard drainage, station sumps, and sewage treatment would not be expected to change due to the power uprate. The changes in discharges to the river resulting from this uprate would remain within the bounding conditions established in the NPDES permit and, therefore, would have minimal impact either individually or cumulatively on the environment.

No changes are expected to be required to the plant intake system as a result of this project. The amount of water projected to be withdrawn from the river remains within the levels evaluated during the original EIS impact analysis for three-unit operation at BFN; therefore, this project would not significantly impact intake water volume.

3.2.8.2. Computer Simulations of NPDES Compliance Measures

Computer simulations for evaluating the need for cooling towers and derating when operating BFN Units 2 and 3 at 120 percent of original licensed thermal power (OLTP) were conducted using meteorological and water temperature data from 1985 to 2002, excluding 1989 and 1990 (years for which necessary data were unavailable). The results of the simulations indicated that existing cooling towers would provide adequate cooling to operate Units 2 and 3 at 120 percent of OLTP except in severely hot and dry conditions, when derating the plant would be necessary to remain in compliance with in-stream thermal limits in the current NPDES permit. Computer modeling EPU operation of Units 2 and 3 using the available weather data since 1985 predicted a total of 128 hours of derating in the 16-year modeling period. The model predicted that 25, 55, 39, and 9 hours of derating would have been needed for equivalent weather years 1986, 1993, 1999, and 2002, respectively.

The simulations indicated that the combination of using existing cooling towers and derating the plant would allow compliance with the current NPDES permit.

3.2.8.3. Far-Field Modeling Water Temperature Results

The implications of the thermal effects on reservoir water temperatures, dissolved oxygen (DO) concentrations, and eutrophication were evaluated using a far-field, two-dimensional reservoir model (Shiao, et al., 1993). The model was run for six years (1987-1994, excluding results for 1989 and 1990, where meteorological data are not available) using estimated hourly withdrawals and releases from BFN, as well as flow data from Guntersville and Wheeler Dams. The six-year time frame selected for the far-field analysis included a range of operating conditions, including severely hot and dry years, a relatively cold and wet year, and a year of approximately average conditions. Results of the modeling analysis are shown in Table 3-2 for two reservoir segments: upstream of BFN (TRMs 295.9-294.0) and the reservoir forebay (TRMs 280.7-274.9), which is downstream of BFN and upstream of Wheeler Dam.

The mean temperature over the six-year model simulation period predicted for the reservoir forebay segment increased from 65.7°F to 65.8°F as Units 2 and 3 were uprated from 105 percent to 120 percent. For all three units operating at 100 percent OLTP, the six-year mean water temperature predicted at the reservoir forebay segment was 66.1°F. Thus, the proposed two-unit operation at 120 percent represents a decrease of 0.3°F compared to all three units operating at their initial 100 percent OLTP and a 0.1°F increase compared to two units operating at 105 percent OLTP. Six-year means of the predicted water temperatures for July and August showed a similar trend for the reservoir forebay segment.

The maximum daily temperature (i.e., the warmest daily average river temperature) over the six-year simulation period predicted for the reservoir forebay was 90.6°F for all three cases for the years modeled. Thus, the maximum daily temperature downstream of BFN at the reservoir forebay would not be expected to change measurably with the proposed uprate of Units 2 and 3 to 120 percent of OLTP.

3.2.8.4. Far-Field Modeling Algal Biomass and Dissolved Oxygen (DO) Concentrations Results Wheeler Reservoir Forebay Segment

The six-year modeling analysis of algal and DO concentrations upstream of the plant and in the reservoir forebay were essentially unchanged under all three operating cases. Thus, significant changes in algal and DO concentrations would not be expected with the proposed operation of Units 2 and 3 at 120 percent of OLTP.

Based on these results and future operation of the plant in compliance with regulatory requirements for thermal effects, operation of Units 2 and 3 at 120 percent of OLTP would be expected to have insignificant effects on reservoir stratification, DO concentrations, eutrophication, and cumulative impacts.

3.2.9. Aquatic Ecology

3.2.9.1. Fish

In 1985, BFN initiated a three-phase biological monitoring program to evaluate the effects of the BFN thermal discharge on total standing stocks and selected fish species in Wheeler Reservoir and a sampling program to monitor total standing stocks of fish in Wheeler Reservoir. The results were reported to the state of Alabama in 1998 (Baxter and Buchanan, 1998), and additional analyses of the data were provided as part of the NPDES permit renewal application submitted in September 1999 (TVA, 1999). Both the final report and the additional analyses concluded that the operation of BFN under the current permit limitations has not had a significant impact on the aquatic community of Wheeler Reservoir or on the specific aquatic species studied.

Two species of special interest, sauger and yellow perch, were the focus of BFN thermal variance studies because both are considered coolwater species and, theoretically, more susceptible to elevated water temperature. Based on results of studies conducted from 1985 through 1992, operation of BFN had no significant adverse impact on the reproductive success of either species or the movement of sauger past BFN. However, the studies did indicate sauger-spawning success was adversely impacted by overfishing (Maceina, et al., 1998), and drought conditions (e.g., low flows and decreased turbidity) in the Tennessee Valley during 1985 through 1988. The operation of BFN had not impacted the sauger population in Wheeler Reservoir (Baxter and Buchanan, 1998).

Cove rotenone samples were collected annually from 1969 through 1997 as a component of the TVA environmental monitoring program for BFN. These samples provided a database on the fish community in the vicinity of BFN and later served as a part of the thermal variance monitoring program. In more recent samples, 52 species were collected in 1995, 45 species in 1996, and 43 species in 1997. Annual standing stock estimates were 105,655 fish/hectare (ha) and 683 kilograms (kg)/ha in 1995 and decreased to 11,713 fish/ha and 366 kg/ha in 1996, then increased to 24,497 fish/ha and 489 kg/ha in 1997. As usual, forage fish were numerically dominant in samples and dominated biomass estimates in 1995 and 1996, but rough fish were highest in biomass in 1997. Gizzard shad exhibited the highest biomass during all three years, followed by threadfin shad in 1995 and smallmouth buffalo in 1996 and 1997 (Baxter and Buchanan, 1998).

Table 3-2. Summary of Wheeler Reservoir Water Quality Far-Field Computer Model Results for Equivalent Weather Years 1987-1988, 1991-1994[1]

Parameter (Units)	Upstream of BFN Reservoir Segment TRM 295.9-294.0			Reservoir Forebay Segment TRM 280.7-274.9		
Temperature (°F)[2]	**Max. Day[3]**	**Mean[4]**	**July-Aug. Mean[5]**	**Max. Day**	**Mean**	**July-Aug. Mean**
3 Units at 100%	90.2	65.6	84.6	90.6	66.1	85.1
2 Units at 105%	90.1	65.1	84.2	90.6	65.7	84.8
2 Units at 120%	90.2	65.2	84.3	90.6	65.8	84.9
Difference (120%-100%)	0.0	-0.4	-0.3	0.0	-0.3	-0.2
Algal Biomass (milligrams per liter [mg/L])[6]	**Max. Day**	**Mean**	**July-Aug. Mean**	**Max. Day**	**Mean**	**July-Aug. Mean**
3 Units at 100%	7.0	3.4	6.1	7.7	3.4	6.1
2 Units at 105%	7.2	3.5	6.3	8.1	3.5	6.2
2 Units at 120%	7.2	3.5	6.2	8.0	3.5	6.2
Difference (120%-100%)	0.2	0.1	0.1	0.3	0.1	0.1
Dissolved Oxygen (mg/L)[7]	**Min. Day[8]**	**Mean**	**July-Aug. Mean**	**Min. Day**	**Mean**	**July-Aug. Mean**
3 Units at 100%	5.3	8.8	6.8	3.5	8.0	5.2
2 Units at 105%	4.8	8.8	6.8	2.9	7.9	4.8
2 Units at 120%	4.8	8.8	6.7	2.9	7.9	4.8
Difference (120%-100%)	-0.5	0.0	-0.1	-0.6	-0.1	-0.4

[1] All values in table are based on the daily average for parameter indicated. 1989-1990 model results were omitted because historical meteorological data were not available.
[2] All temperature values are based on model results at the 5-foot depth.
[3] Max. day is the maximum average daily value (1 day) out of the six-year period.
[4] Mean is the average of all daily values (2,192 days) over the six-year period.
[5] July-Aug. mean is the average of all June and July daily values (520 days) over the six-year period.
[6] Algal biomass values are based on model results at the 5-foot depth.
[7] Dissolved oxygen values are based on model results for the water column average.
[8] Min. day is the minimum average daily value (1 day) out of the six-year period.

TVA has conducted extensive sampling of the fish community in the vicinity of BFN and elsewhere in Wheeler Reservoir in recent years, both in monitoring programs conducted specifically for BFN (Baxter and Buchanan, 1998) and as part of TVA's Reservoir Monitoring Program (Dycus and Baker, 2000). Fifty-seven species have been collected in recent years by various sampling methods (see Appendix Table A-1).

TVA began a program to monitor the ecological conditions of its reservoirs systematically in 1990. Previously, reservoir studies had been confined to assessments to meet specific needs as they arose. Reservoir (and stream) monitoring programs were combined with TVA's fish tissue and bacteriological studies to form an integrated Vital Signs Monitoring Program. Vital signs monitoring activities focus on: (1) physical/chemical characteristics of waters; (2) physical/chemical characteristics of sediments; (3) benthic macroinvertebrate community sampling; and (4) fish assemblage sampling. Fish are included in aquatic monitoring programs because they are important to the aquatic food chain and because they have a long life cycle, which allows them to reflect conditions over time. Fish are also important to the public for aesthetic, recreational, and commercial reasons (Dycus and Baker, 2000).

Fish samples were taken in three areas of Wheeler Reservoir from 1993 through 1995, 1997, 1999, and 2000 through 2002 as part of TVA's Reservoir Vital Signs Monitoring Program. Areas sampled included the forebay (area of the reservoir nearest the dam), a midreservoir transition station in the vicinity of TRM 295.9, an upper-reservoir inflow station at TRM 348, and the Elk River embayment. Results of sampling at the transition stations and cove rotenone surveys of Wheeler Reservoir are presented in Appendix Table A-1 (Baxter and Gardner, 2003). These data are more representative of fish communities in the vicinity of BFN.

Reservoir Fish Assemblage Index (RFAI) ratings are based primarily on fish community structure and function. Also considered in the rating is the percentage of the sample represented by omnivores and insectivores, overall number of fish collected, and the occurrence of fish with anomalies such as diseases, lesions, parasites, deformities, etc. Compared to other run-of-the-river reservoirs, the fish assemblage at the Wheeler midreservoir station (TRM 295.9) rated poor in 1992 and 1999, fair in 1990, 1991, 1995, and 1997, and good in 1993 and 1994. Annual electrofishing and gill net samples were collected since 2000 at the upstream of BFN sampling station (TRM 295.9) and a downstream (below the BFN diffuser mixing zone) sampling station at TRM 292.5. The average fish assemblage index scores from 1993 through 2002 rated good at TRM 292.5 and fair at TRM 295.9 (Appendix Table A-2) (Baxter and Gardner, 2003).

Results since 1991 indicate no adverse impacts to the aquatic community of Wheeler Reservoir as a result of BFN operation (Baxter and Gardner, 2003). Based on the results reported in that document and the findings of the present EA that the expected impacts on thermal conditions for water quality, reservoir stratification, DO concentrations, and eutrophication are expected to be insignificant, effects on the reservoir fishery are also expected to be insignificant. To confirm the expected low level of effects, TVA will continue the current monitoring scheme for three years following implementation of the EPU.

3.2.9.2. Entrainment and Impingement of Fish and Shellfish, Heat Shock

Fish eggs and larvae entrained in cooling water may suffer mortality from one or more physical effects of passage through the plant. Consequently, in conjunction with the construction of BFN, TVA investigated the preoperational characteristics and dynamics of the annual ichthyoplankton populations in Wheeler Reservoir (TVA, 1978a). This investigation was continued through the initiation of commercial operation in 1974, and data from 1971-1977 were reported (TVA, 1978b); 1978 and 1979 data were also reported (TVA, 1980). These studies concluded that estimated plant entrainment under open-cycle, three-unit operation would not add significantly to expected natural mortality of fish eggs and larvae in the reservoir (TVA, 1980); overall impingement did not appear to represent an adverse environmental impact to the Wheeler fish community (TVA, 1978b).

Response of fish and other aquatic life to elevated temperatures found in power plant discharges can range from acute (which includes immediate disability and death) to chronic or low level (which may include physiological or behavioral responses such as changes in spawning, migration, or feed behaviors). Since the discharge diffusers at BFN are located such that fish do not become trapped in areas of elevated temperatures, acute impacts are highly unlikely. TVA studies have documented that thermal releases from BFN have not had a significant impact on the aquatic community of Wheeler Reservoir (Baxter and Buchanan, 1998).

The volume of water withdrawn from the reservoir would remain within the levels evaluated during the original EIS impact analysis for three-unit operation at BFN; therefore, neither Alternative A nor Alternative B would impact entrainment and impingement levels beyond those currently permitted at BFN. In-stream temperatures at the end of the mixing zone would remain within NPDES permitted limits; thus, heat shock impacts would not be anticipated.

Based on these results, entrainment, impingement, and potential for heat shock from the extended power uprate of Units 2 and 3 at 120 percent of OLTP would also be expected to have insignificant effects on the reservoir fishery and general biological community.

3.2.9.3. Benthic Organisms

As mentioned, BFN is located on Wheeler Reservoir, which TVA classifies as a run-of-the-river reservoir. Run-of-the-river reservoirs typically have short water retention times (one to two weeks) and little winter drawdown. Benthic habitats in the reservoir range from deposits of finely divided silts to river channel cobble and bedrock. The most extensive benthic habitat is composed of fine-grained brown silt, which is deposited both in the old river channel and on the former overbank areas. The overbank areas, on either side of the old river channel, are far more extensive than the channel and are the most productive (TVA, 1972). These overbanks, located directly across from BFN, extend approximately two miles downstream. The overbanks support communities of Asiatic and fingernail clams, burrowing mayflies, aquatic worms, and midges. Cobble and bedrock areas, found primarily in the old channel, support Asiatic clams, bryozoa, sponges, caddisflies, snails, and some leeches. The Asiatic clam is not indigenous to North America, but is common in the Tennessee River system.

Benthic macroinvertebrates are included in the previously mentioned Vital Signs Monitoring Program because of their importance to the aquatic food chain and because they have limited capability of movement, thereby preventing them from avoiding undesirable conditions. Since 1995, vital signs samples have been collected in the late fall/winter (November-December). Depending on reservoir size, as many as three stations are sampled (i.e., inflow, transition, and forebay).

Benthic macroinvertebrate vital signs monitoring data are analyzed using several metrics. The number of metrics has varied through the sample years as reservoir benthic analysis has been fine-tuned. The most recent analysis is comprised of seven metrics: taxa richness; *Ephemeroptera, Plecoptera,* and *Tricopertera* (EPT) taxa; long-lived taxa; percent oligochaete; dominance; zero samples; and non-chironomid and oligochaete density. The number derived for each metric is totaled, and the score is applied to a range of values listed in Appendix Table A-3 that identify the overall condition of the benthic community (i.e., very poor, poor, fair, good, or excellent).

BFN is located a short distance downstream from the vital signs transition station on Wheeler Reservoir (TRM 295.9). The transition station is the zone considered to be between riverine (the inflow station) and impoundment habitats (the forebay station). Benthic community scores at the transition station ranged from “excellent” in 1994 to “good” in 1995 and “excellent” again in 1997 and 1999 (Dycus and Baker, 2000).

In addition to vital signs benthic macroinvertebrate monitoring, benthic community sampling in support of BFN thermal variance monitoring was begun in the fall of 2000 (and will continue at least for the term of the current permit cycle—five years). Station locations are TRM 295.9 and TRM 291.7, upstream and downstream of the BFN diffusers, respectively (Appendix Table A-3). The average benthic index scores found above BFN diffusers to be in “excellent” condition and “good” condition below the diffusers (Baxter and Gardner, 2003).

Freshwater mussel fauna are not assessed as part of TVA’s Vital Signs Monitoring Program; however, they are excellent indicators of water quality due to their sessile nature and inability to avoid perturbations impacting water quality. Mussels feed on microorganisms (protozoans, bacteria, diatoms) and organic particles suspended in the water that are brought into the body via siphon action and consumed.

Thirty-eight freshwater mussel species had been documented in Wheeler Reservoir through 1991 (Ahlstedt and McDonough, 1993). Twelve species were identified in the vicinity of BFN during a 1982 survey for a proposed barge facility (Henson and Pryor, 1982). Most recently, Alabama Fish and Game identified 14 species upstream of BFN and 12 species downstream (Jeffrey T. Garner, Alabama Game and Fish Division malacologist, personal communication, 2001). A listing of these species appears in Appendix Table A-4.

Table 3-2 illustrates computer-modeling results for the six-year far-field analysis. As shown in the table, the model predicted that two units operating at 120 percent OLTP would result in a 0.2ºF lower July-August average mean temperature in Wheeler Reservoir forebay than three units operating at 100 percent OLTP. Any increase in discharge temperature would result in increased cooling tower usage and possible derate of the plant during summer periods. Water intake velocity would not change from that which was evaluated during previous studies when all three units were in operation at BFN. Therefore, no impacts to benthic macroinvertebrate communities due to discharge temperatures or entrainment are expected in the vicinity of BFN because of this action.

3.2.10. Threatened and Endangered Species - Aquatic

Five federally endangered aquatic species are known to occur in the vicinity of BFN. The rough pigtoe (*Pleurobema plenum*) and the pink mucket (*Lampsilis abrupta*) are freshwater mussels that historically occurred in silt-free, stable gravel and cobble habitats in large river habitats throughout the Tennessee River system (Parmalee and Bogan, 1998). These species are now extremely rare and are primarily found in unimpounded tributary rivers and in the more riverine reaches of the largely impounded mainstem Tennessee River. In Wheeler Reservoir, most of the surviving large river habitat occur upstream of BFN. All recent records of these two species are from upstream of BFN (Ahlstedt and McDonough, 1993; Colaw and Carroll, 1982; Jeffrey T. Garner, Alabama Game and Fish Division malacologist, personal communication, 1998 and 2001; Gooch, et al., 1979; Henson and Pryor, 1982; TVA, 2003; Yokely, 1998). It is very unlikely that populations of these species exist in Wheeler Reservoir downstream of BFN (Leroy M. Koch, United States Fish and Wildlife Service [USFWS] field supervisor, Daphne, Alabama, personal communication, 1999).

Three federally listed endangered aquatic snails; armored snail (*Pyrgulopsis pachyta*), slender campeloma (*Campeloma decampi*), and Anthony's river snail (*Leptoxis* [=Athearnia] *anthonyi*), are restricted to tributary creeks to Wheeler Reservoir, located upstream from BFN (Appendix Table A-5). No evidence exists to suggest that populations of these species exist in the mainstem of the Tennessee River (Wheeler Reservoir) in the vicinity of BFN, or in tributary streams downstream of BFN. One state-listed snail, Warty Rocksnail (*Lithasia lima*), is reported from tributary streams upstream of BFN, but is not likely to occur in the mainstem Tennessee River adjacent to or downstream of BFN. Vital signs monitoring data and TVA's Regional Natural Heritage Program's most recent database indicates no state or federally protected fish species have been collected, or are currently known to occur in the vicinity of BFN.

The expected impacts from use of additional derating of BFN in combination with use of existing cooling towers on thermal conditions for water quality, reservoir stratification, DO concentrations, eutrophication, and condition of general reservoir biological communities would be minor, insignificant, and within the bounds of the previously permitted thermal discharge of the plant for three-unit operation. Therefore, no effects to any federally listed species are expected. The nature of the present TVA action with its limited geographical area of influence has no potential for effects on other federally listed species.

TVA's corporate Environmental Policy commits the agency to protecting environmental resources of the Tennessee Valley. TVA's Environmental Principles include assessing the effects of TVA operations to ensure environmental compliance. TVA has monitored Wheeler Reservoir since 1985 to assure that plant operation does not adversely impact Wheeler Reservoir. In accordance with the NPDES permit and previous commitments (TVA, 1999; 2002), TVA will continue annual monitoring of reservoir conditions. This monitoring is to confirm results of thermal modeling that indicate no significant impact on a balanced indigenous population of fish, shellfish, and wildlife, in and on Wheeler Reservoir from the EPU of BFN Units 2 and 3. Annual monitoring results will be reported to the state of Alabama.

3.2.11. Socioeconomic and Environmental Justice

3.2.11.1. Socioeconomics

BFN is located in Limestone County, Alabama, which is part of the Huntsville metropolitan area. The population of Limestone County in 2000 was 65,676 (U.S. Bureau of the Census, *Census of Population 2000*). The primary labor market area for the plant consists of three metropolitan areas: Huntsville (Limestone and Madison Counties), Decatur

(Lawrence and Morgan Counties), and Florence (Colbert and Lauderdale Counties). The 2000 population of this area was 631,193. Based on 2002 data, the labor force in Limestone County is 31,275; the primary labor market area has a labor force of 311,789 (Alabama Department of Industrial Relations, Labor Market Information Division). The unemployment rate in 2002 was 5.3 percent in Limestone County, while the average in the primary labor market area was 6.2 percent.

The proposed action would be one activity that would occur during a planned outage, which is expected to last for 35 days. Total employment for all activities during this outage would peak at approximately 1,000. Staffing would begin about four to five weeks prior to this peak, with destaffing scheduled to begin around day 28 of the outage. This maximum employment level would represent about 3.2 percent of the current labor force of Limestone County and about three-tenths of 1 percent of the labor force in the primary labor market area.

In addition to the areas included in the primary labor market area, the Birmingham, Alabama and Nashville, Tennessee areas are likely sources of workers for the proposed activity. Workers from these areas generally would commute rather than relocate for the short duration of the proposed activity. Previous TVA experience at the BFN site and at other construction sites suggest that it is likely that no more than one-third of all the workers hired for construction or similar activities would move into the primary labor market area. The remaining workers generally would already reside within the primary labor market area or in a location, such as the Birmingham or Nashville areas, close enough to commute on a temporary basis. Based on this, it is anticipated that the maximum impact from workers moving into the area would be about 300 to 350 workers, not all resulting from this proposed action. Because of the very short-term nature of the work—about five weeks—and the short duration of the maximum employment level, very few workers who do move in are expected to bring families with them. It is not likely that the increased population in the area due to all outage activities would exceed about 400 persons. However, it is possible that the demand for the required skills would make recruiting difficult, resulting in a somewhat larger number of workers moving temporarily into the local area.

Due to the short term of the project, the total impact on annual earnings and income in Limestone County and in the labor market area would be very small and insignificant. Impacts on community services such as police, fire, and medical would also be very small and insignificant because of the small size of the impact on population, because the workers who move likely would be dispersed within the labor market area, and because of the short duration of the maximum impact.

3.2.11.2. Environmental Justice

The population of Limestone County is 17.6 percent minority, well below both the state of Alabama, with 29.7 percent, and the nation, with 30.9 percent (U. S. Bureau of the Census, *Census of Population, 2000*). The labor market area has a higher minority population share, 22.1 percent, still well below the state and national levels. The poverty rate in Limestone County is 12.3 percent, lower than the state average of 16.1 percent and about the same as the national average of 12.4 percent (U.S. Bureau of the Census, *Census of Population, 2000*). The poverty rate in the labor market area is 12.1 percent, lower than Limestone County, the state, and the nation.

As discussed above, the area around the plant has relatively low poverty rates and small minority populations. Almost all of the activity associated with the proposed action would occur inside the plant, further removing it from the population in the surrounding area. Also, no significant negative impacts to the environment are expected if the proposed action occurs. Therefore, no disproportionate negative impacts to disadvantaged populations are expected.

3.3. Cumulative Impacts

The far-field effects computer modeling, which was described above, indicated that the operation of BFN Units 2 and 3 at 120 percent of OLTP with existing cooling towers and derating would not result in significant increases in average reservoir temperature downstream of BFN at the Wheeler Reservoir forebay segment.

The cumulative effects of the planned restarting of BFN Unit 1 at 120 percent of OLTP in conjunction with operating Units 2 and 3 at 120 percent of OLTP were evaluated and addressed in TVA, 2002, which found that with the commitments noted therein, cumulative impacts would not be significant. That analysis of cumulative effects incorporated the assumption of BFN Units 2 and 3 operating at 120 percent of OLTP. For the EPU of BFN Units 2 and 3, maintaining thermal discharges within the current NPDES permit limits by using existing cooling towers and derating would be the strategy employed until the planned restart of BFN Unit 1. At restart of BFN Unit 1, as described in the Final SEIS and ROD (TVA, 2002), the use of existing cooling towers, operation of an additional new cooling tower and derating as needed, would then become the combination employed to maintain BFN operations within current permit limits.

3.4. Summary of TVA Commitments and Proposed Mitigation Measures

If this project is implemented, TVA would use existing cooling towers and derate BFN Units 2 and 3 as necessary to maintain compliance with thermal limits specified by the NPDES permit and to ensure that potential impacts to reservoir water and ecological conditions are insignificant.

In accordance with the NPDES permit and previous commitments (TVA, 1999; 2002), TVA will continue annual monitoring of reservoir conditions. This monitoring will continue for three years following implementation of the EPU and is to confirm results of thermal modeling that indicate no significant impact on a balanced indigenous population of fish, shellfish, and wildlife, in and on Wheeler Reservoir from the EPU of BFN Units 2 and 3. Annual monitoring results will be reported to the state of Alabama.

Spent fuel would be stored in an NRC licensed and approved facility.

CHAPTER 4

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CHAPTER 5

5. SUPPORTING INFORMATION

5.1. Literature Cited

ADEM. 2002. ADEM final listing decision for Wheeler Reservoir on the Tennessee River waterbody identification number AL/Wheeler_Res01 pH temperature/thermal modification. Alabama Department of Environmental Management, Water Quality Branch, Water Division.

Ahlstedt, S. A., and T. A. McDonough. 1993. Quantitative evaluation of commercial mussel populations in the Tennessee River portion of Wheeler Reservoir, Alabama. Pages 38-49 in K. S. Cummings, A. C. Buchanan, and L. M. Koch (editors). Conservation and management of freshwater mussels. Proceedings of an Upper Mississippi River Conservation Committee (UMRCC) symposium, 12-14 October 1992, St. Louis, Missouri. UMRCC, Rock Island, Illinois.

Baxter, D. S., and J. P. Buchanan. 1998. Browns Ferry Nuclear Plant Thermal Variance Monitoring Program - final report. Tennessee Valley Authority, Water Management, Environmental Compliance.

Baxter, D. S., and K. D. Gardner. 2003. Biological monitoring of the Tennessee River near Browns Ferry Nuclear Plant discharge, 2002. Tennessee Valley Authority, Resource Stewardship, Aquatic Biology Laboratory, Norris, Tennessee, 21 pages.

Colaw, L. W., and B. B. Carroll. 1982. Mallard-Fox mussel survey report. Unpublished report, Tennessee Valley Authority, Fisheries and Ecology Branch, Division of Water Resources, Knoxville, Tennessee, 4 pages.

Dycus, D. L., and T. F. Baker. 2000. Aquatic ecological health determinations for TVA reservoirs –1999. Tennessee Valley Authority, Water Management, Chattanooga, Tennessee.

Gooch, C. H., W. J. Pardue, and D. C. Wade. 1979. Recent mollusk investigations on the Tennessee River, 1978. Unpublished report, Tennessee Valley Authority, Division of Environmental Planning, Muscle Shoals, Alabama, and Chattanooga, Tennessee, 126 pages.

Henson, J. R., and R. J. Pryor. 1982. Browns Ferry Nuclear Plant - proposed barge facility. Unpublished report, Tennessee Valley Authority, Fisheries and Ecology Branch, Division of Water Resources, Knoxville, Tennessee, 4 pages.

Maceina, M. J., P. W. Bettoli, S. D. Finely, and V. J. DiCenzo. 1998. Analyses of the sauger fishery with simulated effects of a minimum size limit in the Tennessee River of Alabama. North American Journal of Fisheries Management 18:104-113.

Nuclear Regulatory Commission. Fact sheet on power uprates for nuclear plants. June 23, 2003 <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/power-uprates.html> (July 23, 2003).

Parmalee, P. W., and A. E. Bogan 1998. The Freshwater Mussels of Tennessee. The University of Tennessee Press, Knoxville, pages 124 and 190.

Shiao, M. C, M. D. Bender, and G. E. Hauser. 1993. Two-dimensional water quality modeling of Wheeler Reservoir. TVA Resource Group, Engineering Services, Hydraulic Engineering, WR28-1-3-105, Norris, Tennessee.

Tennessee Valley Authority. 1972. Browns Ferry Nuclear Plant, Units 1, 2, and 3, final environmental impact statement. TVA Office of Health and Environmental Science, Chattanooga, Tennessee.

______. 1978a. Browns Ferry Nuclear Plant preoperational fisheries resources report. TVA Division of Forestry, Fisheries, and Wildlife Development, Norris, Tennessee.

______. 1978b. Biological effects of intake - Browns Ferry Nuclear Plant, volume 4: Effects of the Browns Ferry Nuclear Plant cooling water intake on the fish populations of Wheeler Reservoir. TVA Division of Forestry, Fisheries, and Wildlife Development, Norris, Tennessee.

______. 1980. Fish entrainment and impingement at Browns Ferry Nuclear Plant, Wheeler Reservoir, Alabama, for the years 1978 and 1979. TVA Division of Water Resources, Fisheries, and Aquatic Ecology Branch, Norris, Tennessee.

______. 1995. Energy vision 2020 – integrated resource plan/programmatic environmental impact statement.

______. 1997. Browns Ferry Nuclear Plant, Units 2 and 3 power uprate project final environmental assessment.

______. 1999. Browns Ferry Nuclear Plant - National Pollutant Discharge Elimination System permit number AL 0022080 - renewal application.

______. 2001. Browns Ferry Nuclear Plant extended power uprate for Units 2 and 3 final environmental assessment.

______. 2002. Final supplemental environmental impact statement for operating license renewal of the Browns Ferry Nuclear Plant in Athens, Alabama.

______. 2003. TVA Natural Heritage Database. Norris, Tennessee.

Yokely, P., Jr. 1998. Mussel study near Hobbs Island on the Tennessee River for Butler Basin Marina. Unpublished report prepared for MST Engineering, Decatur, Alabama, 2 pages.

5.2. Glossary of Terms

°F	Degree Fahrenheit
ADEM	Alabama Department of Environmental Management
ALARA	As low as reasonably achievable
Baseload	The minimum amount of electric power or natural gas delivered or required over a given period of time at a steady rate. The minimum continuous load or demand in a power system over a given period of time usually not temperature sensitive.
BFN	Browns Ferry Nuclear Plant
CFR	Code of Federal Regulation
cfs	Cubic feet per second
Cooling Water	Water pumped through the condensers of a steam-cycle power plant to extract heat from steam after it has exited the turbines in order to return it to a liquid state.
Cumulative Impacts	In an EIS or EA, the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal), private industry, or individual(s) undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).
Derate	Reduction in operating power production level.
DO	Dissolved oxygen
EA	Environmental Assessment
Effluent	A gas or fluid discharged into the environment
e.g.	Latin term, exempli gratia, meaning “for example”
EIS	Environmental Impact Statement
EPT	Ephemeroptera, Plecoptera, and Tricopertera
EPU	Extended power uprates
et al.	Latin term et alii (masculine), et aliae (feminine), or et alia (neutral) meaning “and others”

FONSI	Finding of No Significant Impact
ha	hectare
HWSF	Hazardous Waste Storage Facility
IDT	Interdisciplinary Team
i.e.	Latin term, id est, meaning “that is”
kg	kilogram
Megawatt (MW)	A unit of power equal to 1 million watts
Megawatt-electric (MWe)	Term commonly used to define electricity produced
Megawatt-thermal (MWt)	Term commonly used to define heat produced
mgd	Million gallons per day
mg/L	Milligrams per liter
N-16 (Nitrogen-16)	An isotope of nitrogen
NEDC (Nuclear Energy Document Customer)	General Electric Company report designation usually followed by a number
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
OLTP	Original licensed thermal power
Peak Load	The maximum load consumer or produced by a unit or group of units in a stated period of time
rem	The unit of radiation dose equivalent
RFAI	Reservoir Fish Assemblage Index
ROD	Record of Decision
SEIS	Supplemental Environmental Impact Statement
TLD	Thermoluminescent dosimeter
TRM	Tennessee River Mile

TVA	Tennessee Valley Authority
Uprate	To increase rated power output
USFWS	United States Fish and Wildlife Service

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APPENDIX A – TABLES

Appendix Table A-1. Fish Species Collected in the Vicinity of Browns Ferry Nuclear Plant by TVA during BFN Reservoir Monitoring Activities, 1995-2002

	Cove Rotenone	Fall 2000 Gill Net and Electrofishing		Fall 2001 Gill Net and Electrofishing		Fall 2002 Gill Net and Electrofishing	
	1995-1997	TRM 292.5	TRM 295.9	TRM 292.5	TRM 295.9	TRM 292.5	TRM 295.9
Common Name							
Chestnut lamprey	x	-	-	-	-	-	-
Spotted gar	x	-	x	-	x	x	-
Longnose gar	x	-	-	-	-	-	-
Bowfin	x	-	-	-	-	-	-
Skipjack herring	x	x	x	x	x	x	x
Gizzard shad	x	x	x	x	x	x	x
Threadfin shad	x	x	x	x	x	x	x
Central stoneroller	x	-	-	x	-	-	-
Grass carp	-	-	x	-	-	-	-
Spotfin shiner	x	-	-	x	-	-	-
Steelcolor shiner	x	-	-	-	-	-	-
Common carp	x	-	x	x	x	-	x
Striped shiner	x	-	-	-	-	-	-
Silver chub	x	-	-	-	-	-	-
Golden shiner	x	-	-	x	x	-	x
Emerald shiner	x	x	x	x	x	-	x
Ghost shiner	x	-	-	-	-	-	-
Mimic shiner	x	-	-	-	x	-	-
Bullhead minnow	x	-	-	x	-	-	x
Northern hog sucker	x	x	x	-	-	-	x
Smallmouth buffalo	x	x	x	x	x	x	x
Bigmouth buffalo	x	-	-	-	-	-	x
Spotted sucker	x	x	x	x	x	x	x
Silver redhorse	x	-	-	-	-	-	-
River redhorse	-	x	x	-	-	-	-
Black redhorse	-	x	-	x	-	x	x
Golden redhorse	x	-	-	x	-	x	-
Shorthead redhorse	x	-	-	-	-	-	-

	Cove Rotenone	Fall 2000 Gill Net and Electrofishing		Fall 2001 Gill Net and Electrofishing		Fall 2002 Gill Net and Electrofishing	
	1995-1997	TRM 292.5	TRM 295.9	TRM 292.5	TRM 295.9	TRM 292.5	TRM 295.9
Common Name							
Black bullhead	x	-	-	-	-	-	-
Yellow bullhead	x	-	-	-	-	-	-
Brown bullhead	x	-	-	-	-	-	-
Blue catfish	x	x	x	x	x	x	x
Channel catfish	x	x	x	x	x	x	x
Flathead catfish	x	x	x	x	x	x	x
Blackstripe topminnow	x	-	-	-	-	-	-
Blackspotted topminnow	x	-	-	-	-	-	-
Western mosquitofish	x	-	-	-	-	-	-
Brook silverside	x	x	-	-	-	-	-
Inland silverside	x	-	-	x	x	x	x
White bass	x	x	x		x	x	x
Yellow bass	x	x	x	x	x	x	x
Hybrid striped x white bass	-	-	x	-	x	x	x
Striped bass	-	x	-	x	x		x
Redbreast sunfish	x	-	-	-	-	-	-
Green sunfish	x	-	-	x	x	x	x
Warmouth	x	-	x	-	x	-	-
Orangespotted sunfish	x	-	-	-	-	-	-
Bluegill	x	x	x	x	x	x	x
Longear sunfish	x	x	-	x	x	x	x
Redear sunfish	x	x	x	x	x	x	x
Hybrid sunfish	x	-	-	x	-	-	-
Smallmouth bass	x	x	x	x	x	x	x
Spotted bass	x	x	x	x	x	x	x
Largemouth bass	x	x	x	x	x	x	x
White crappie	x	-	-	x	x	x	-
Black crappie	x	-	-	-	x	-	-
Stripetail darter	x	-	-	-	-	-	-

	Cove Rotenone	Fall 2000 Gill Net and Electrofishing		Fall 2001 Gill Net and Electrofishing		Fall 2002 Gill Net and Electrofishing	
	1995-1997	TRM 292.5	TRM 295.9	TRM 292.5	TRM 295.9	TRM 292.5	TRM 295.9
Common Name							
Yellow perch	x	-	x	-	-	-	-
Logperch	x	x	x	x	x	-	-
River darter	x	-	-	-	-	-	-
Sauger	x	x	x	x	x	x	x
Freshwater drum	x	x	x	x	x	x	x
Mooneye	-	-	-	-	x	-	-
Bluntnose minnow	-	-	-	-	x	-	-
Hybrid walleye x sauger	-	-	-	-	x	-	-
Black buffalo	-	-	-	-	-	-	x
Number Species Collected	57	25	27	31	34	25	30

Appendix Table A-2. Average Vital Signs Monitoring RFAI Metric Scores from 1993 through 2002 in the Vicinity of Browns Ferry Nuclear Plant, Wheeler Reservoir

			Year									
Station	**Reservoir**	**Location**	**1993**	**1994**	**1995**	**1997**	**1999**	**1993-1999 Average**	**2000**	**2001**	**2002**	**1993-2002 Average**
BFN Upstream Transition	Wheeler	TRM 295.9	43	45	35	42	30	39 (Fair)	41	38	45	40 (Fair)
Downstream Wheeler Forebay	Wheeler	TRM 277	52	44	49	44	42	46 (Good)	-	43	47	46 (Good)
BFN Downstream Transition	Wheeler	TRM 292.5	-	-	-	-	-		43	42	43	43 (Good)

Appendix Table A-3. Recent (1994-2002) Benthic Index Scores Collected as Part of the Vital Signs Monitoring Program at Inflow, Transition (Upstream), and Forebay (Downstream) Sites

			Year									
Site	**Reservoir**	**Location**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Average**
Upstream	Wheeler	TRM 347	31	21		25		23		25	25	25 Good
Upstream	Wheeler	TRM 295.9	33	25		31			31	29	29	30 Excellent
Downstream	Wheeler	TRM 291.7								31	23	27 Good
(Tributary Embayment)	Wheeler	ERM 6	15	13		15		15		15		15 Poor
Downstream	Wheeler	TRM 277	19	15		23		19		17	13	18 Poor

Note: Scores that are considered very poor range from 7-12, poor ranges from 13-18, fair ranges from 19-23, good ranges from 23-29, and excellent ranges from 30-35.

Appendix Table A-4. Mussel Species Collected by Alabama Game and Fish Division Near Browns Ferry Nuclear Plant in 1999

Common Name	Scientific Name
TRM 292, October 13-14, 1999	
Washboard	*Megalonaias nervosa*
Pink heelsplitter	*Potamilus alatus*
Threehorn wartyback	*Obliquaria reflexa*
Mapleleaf	*Quadrula quadrula*
Threeridge	*Amblema plicata*
Pimpleback	*Quadrula pustulosa*
Elephantear	*Elliptio crassidens*
Flat floater	*Anodonta suborbiculata*
Ebonyshell	*Fusconaia ebena*
Fragile papershell	*Leptodea fragilis*
Giant floater	*Pyganondon grandis*
Pistolgrip*	*Tritogonia verrucosa*
TRM 298, August 17 and October 20, 1999	
Washboard	*Megalonaias nervosa*
Pink heelsplitter	*Potamilus alatus*
Pimpleback	*Quadrula pustulosa*
Threehorn wartyback	*Obliquaria reflexa*
Threeridge	*Amblema plicata*
Elephantear	*Elliptio crassidens*
White heelsplitter	*Lasmigona complanata*
Pistolgrip	*Tritogonia verrucosa*
Purple wartyback	*Cyclonaias tuberculata*
Mapleleaf	*Quadrula quadrula*
Butterfly*	*Ellipsaria lineolata*
Giant floater*	*Pyganodon grandis*
Pink papershell*	*Potamilus ohiensis*
Flat floater*	*Anodonta suborbiculata*

* collected as dead shells

Appendix Table A-5. Aquatic Threatened and Endangered Species Known to Occur and Their Federal and State Status From Tennessee River Miles 274.9 to 310.7.

Common Name	Federal Status	State Status
Snails:		
• Anthony's river snail	E	
• Slender campeloma	E	
• Armored snail	E	
Mussels:		
• Spectaclecase		AP, TS
• Butterfly		AS
• Pink mucket	E	AP, KE, TE
• Rough pigtoe	E	AP, TE
• Pink papershell		AS
• Purple lilliput		AS
Crayfish:		
• Troglobitic crayfish		AS
• A troglobitic crayfish		AT
Fish:		
• Spring pigmy sunfish		AP
• Tuscumbia darter		AP, TS
• Paddlefish		AS
• Southern cavefish		AP, TS

Federal Status Codes:
C – Identified candidate
E – Endangered
T – Threatened

State Status Codes:
First letter – State Designation
A – Alabama, G – Georgia, K – Kentucky, M – Mississippi, N – North Carolina,
T – Tennessee, V – Virginia

Second letter – Status In That State
E – Endangered
P – Protected (Alabama) – level of endangerment not specified
S – Various "special concern" categories: In Need of Management, Potential, Rare, etc.
T – Threatened